FUS-TN-SA-SE-R-43

ENTE PER LE NUOVE TECNOLOGIE, L'ENERGIA E L'AMBIENTE

Associazione ENEA-EURATOM sulla Fusione

FUSION DIVISION
NUCLEAR FUSION TECHNOLOGIES

FUSION COMPONENT FAILURE RATE DATABASE (FCFR-DB), VERS. DEC. 2001: USERS MANUAL AND COLLECTED DATA

T. Pinna

EFDA Task TW0 SEA4
Deliverables 1, 2 and 3

Thermonuclear Fusion Division - Safety & Environment
Via E. Fermi 45, I-00044, Frascati (Rome), Italy e-mail: pinna@frascati.enea.it

March 2002

Title:	**Fusion component failure rate database (FCFR-DB), Version December 2001: Users Manual and collected data.**
Reference:	**EFDA Task No. TW0-TRP-SEA4** – Plant Safety Assessment Deliverables 1, 2 and 3
Authors:	T. Pinna (ENEA ERG-FUS TN SIC, C.R.E. Frascati, Italy)
Scope:	The "Fusion Component Failure Rate Database" (FCFR-DB) has been developed to cull statistical data on component failures. The collected data are the ones typically useful in performing safety and reliability analysis on fusion devices. Failure rate data coming from operating experiences on fusion and from other different sources will be gathered in the FCFR-DB. The database is developed in the frame of Lotus Domino and it is installed in an AFX server. It is now accessible "on line" by the way of an INTERNET browsers and Lotus Notes application. The access to the database is restricted to Users operating for fusion, typically to Associations that are IEA members. The web–site, linking the database, is http://spx595.frascati.enea.it:8080/homepage.nsf. The access is regulated by UserIDs and Passwords distributed by ENEA, with the EFDA approval. For each component identified as a "Component class", it is possible to record: data source, operation mode, failure mode, component boundaries, design feature and application field, failure rate values, repair rate values, type of data used to obtain statistical values of failure, suggestion for possible use of the data for design and assessments of fusion device and, information on data handling. About 250 different records related to Component Classes, 470 to Fusion component breakdown, 830 to Common data and, 330 to Users data are recorded in the database at present.

	Emitted by	**Revised by**	**Approved by**
	T. Pinna	M.T. Porfiri	A. Pizzuto
Signatures			

Distribution list:	M. Samuelli, Fusion Division (ENEA, FUS Frascati, Italy) Technologies (ENEA, FUS-TN Frascati, Italy) A. Pizzuto L. Semeraro V. Violante M. Spadoni P. Batistoni A. Cucchiaro B. Riccardi M. Roccella W. Gulden, E. Eriksson (EFDA, Garching, Germany) C. Gordon, H.W. Bartels (ITER-JCT, Garching, Germany) S. Ciattaglia, F. Scaffidi Argentina (JET, Culham, UK) G. Cambi (Bologna University, Italy) L.C. Cadwallader (INEEL, Idaho, USA) P. Petersen (DIII-D, General Atomics, USA), N. Taylor (UKAEA, Culham, UK) L. Di Pace, M.T. Porfiri (ENEA, FUS, Frascati, Italy) ENEA ERG-FUS-TN Secretarial Staff Author: T. Pinna (ENEA, FUS, Frascati, Italy) Archive

CONTENTS

EXECUTIVE SUMMARY

The "Fusion Component Failure Rate Database" (FCFR-DB) has been developed to gather statistical data on component failures. The collected data are the ones typically useful in performing safety and reliability analysis on fusion devices.

The work is carried on in the frame of the EFDA Fusion Technology Work Programme 2000, Task TW0-TRP-SEA4 – Plant Safety Assessment. The overall activity is also set in the frame of the International Energy Agreement (IEA), Task 5.

Because the innovative aspects of fusion devices, generally, not many information are available on literature about availability and reliability of their components. So that, to perform probabilistic assessment of fusion devices, analysts have to consider also data coming from other technological experiences, like nuclear fission power plants, chemical plants, aeronautic, military and industrial systems. This, firstly because it seems very useful to have the largest knowledge of different component behaviours in order to predict availability for fusion facilities safety/reliability assessment. Furthermore, the spread of the data that could be collected referring to the same kind of component can give a good idea of the uncertainty which is being introduced in the analysis, using a given data base.

So that, in the FCFR-DB will be recorded data coming from operating experiences on fusion and from other different sources.

The database is developed in the frame of Lotus Domino and it is installed in a AFX server. It is now accessible "on line" by the way of an INTERNET browsers and Lotus Notes application.

Applications for Lotus Notes have been developed for the data entry and to perform the database administration. Dedicated routines have been built to let the access to data by the way of Internet browsers, like Microsoft Windows Explorer and Netscape.

The access to the database is restricted to Users operating for fusion, typically to Associations that are IEA members. The web – site, linking the database, is http://spx595.frascati.enea.it:8080/homepage.nsf, which is the page dedicated to the ENEA activities on Safety and Environment for fusion technology.

The access is regulated by UserIDs and Passwords distributed by ENEA, with the EFDA approval.

The data related to component failures are recorded in documents. The Common Data set includes the documents yet verified and available for all the Users, while the "Users Data" set includes documents for which the data entry is not yet terminated or, not yet checked and approved.

For each component, identified as a "Component class" it is possible to record: data source, operation mode, failure mode, component boundaries, design feature and application field, failure rate values, repair rate values, type of data used to obtain statistical values of failure, indications about possible use of the data for design and assessments of fusion device and, information on data handling.

About 250 different records related to Component Classes, 470 to Fusion component breakdown, 830 to Common data and, 330 to Users data are recorded in the database at present.

OBJECTIVE

The overall objective of the activity here presented was to realise a specific database, collecting statistical data on component failures, typically the ones useful in performing safety and reliability analysis on fusion devices. The set of data collected should contain, firstly, information for systems foreseen in ITER reactor.

The "Fusion Component Failure Rate Database" (FCFR-DB) has then been developed. The database is now accessible "on line" by the way of an INTERNET browsers and Lotus Notes application.

The work is set in the frame of the EFDA Fusion Technology Work Programme 2000, Task TW0-TRP-SEA4 – Plant Safety Assessment. The overall activity is also set in the frame of the International Energy Agreement (IEA), task 5.

Generally, not many information are available on literature about availability and reliability of the components, because the innovative aspects of fusion devices. So that, to perform probabilistic assessment of fusion devices, analysts have to consider also data coming from other technological experiences, like nuclear fission power plants, chemical plants, aeronautic, military and industrial systems. This disadvantage can turn into an advantage firstly because it seems very useful to have the largest knowledge of different component behaviours in order to predict availability data for fusion facilities safety/reliability assessment. Furthermore, the spread of the data that could be collected referring to the same kind of component can give a good idea of the uncertainty which is being introduced in the analysis, using a given data base.

So that, in the data collection will be recorded data coming from operating experiences on fusion and from other different sources

1. Introduction to the database

The database is developed in the frame of Lotus Domino and it is installed in a AFX server.

Applications for Lotus Notes have been developed for data entry and to perform the database administration (Fig. 1).

Dedicated routines have been built to let the access to data by the way of Internet browsers, like Microsoft Windows Explorer and Netscape (Fig. 2).

The access to the database is restricted to Users operating for fusion, typically to Associations that are IEA members. The web – site, linking the database, is http://spx595.frascati.enea.it:8080/homepage.nsf, which is the page dedicated to the ENEA activities on Safety and Environment for fusion technology (Fig. 3).

The access is regulated by UserIDs and Passwords distributed by ENEA, with the EFDA approval.

The data related to component failures are recorded in documents. Two different type of sets exist: the Common Data and the User Data. The Common Data set includes the documents

available for all the Users, while the "Users Data" set includes documents for which the data entry is not yet terminated or, not yet checked and approved.

2. Common Data

The Common Data set includes the documents that have been yet verified and are available for all the Users.

The retrieval of documents can be done by using several different lists, each one ordering the documents according to different fields and, browsing lists of different information.

The different sorts of data currently foreseen are:

- by Component class,
- by Failure mode,
- by Fusion specific breakdown,
- by Reference, and
- by free choosing.

For each one of the different ways to sort the data, three different fields can be shown in the data lists during the browsing:

- Failure data (related to information on failures),
- Fusion specific breakdown (related to the fusion class assigned to documents),
- Validation info (related to the type of validation, i.e.: effective validation process, IEA consensus)

The single documents can be open by a double "click" of the mouse (see § 7 for the explanation of the document fields).

2.1 by Component class

This function let to browse the Common Data list sorted by "component class", for example electrical, vacuum, hydraulic and so on. In Fig. 4 a sample of the related view in the Internet frame, while in Fig. 5, the view in the Lotus Notes frame.

The lists sorted by "Component class" can be expanded or collapsed according the different levels of the classification, by the way of the dedicated buttons. A "Search" function is available too, to find specific information.

2.2 by Failure mode

This function let to browse the Common Data list sorted by "failure mode". A sample of the related view is reported in Fig. 6.

2.3 by Fusion specific breakdown

In the database information on generic components are correlated to systems/sub-systems/components of fusion facilities in order to give safety analysts and designers of fusion facilities indication about the specific utilisation in fusion field of the recorded data. Precisely, the systems/sub-systems/components of fusion facilities for which the collected data could be taken as reference in performing safety/reliability analyses. This function let to browse the Common Data list sorted by such "Fusion specific breakdown". In Fig. 7 a sample of the related view.

2.4 by Reference

This function let to browse the Common Data list sorted by "References". In Fig. 8 a sample of the related view.

2.5 by free choosing

This function let the Users to select the field to sort the data for the browsing of the Common Data list. In Fig. 9 a sample of the related view.

3. Users data

The "Users Data" set includes documents for which the data entry is not yet terminated or, not yet checked and approved.

The data list is currently sorted for Component class. Date of document recording, description, document status, data validation, IEA consensus, Failure mode and Reference are briefly reported along the list.

The single documents can be open by a double "click" of the mouse (see § 7 for the explanation of the document fields).

The lists can be expanded or collapsed according the different levels of the component classification, by the way of the dedicated buttons. A "Search" function is available too, to find specific information.

In Fig. 10 a sample of the related view.

4. Download

The download function lets the Users to perform the download of the files showed in the list. Typically, the files are sets of data extracted from the database. The files are prepared by the database Administrator. Users that need dedicated files can require them to the Administrator.

In Fig. 11 a sample of the related view.

5. Tables

Several tables are foreseen to generate a fixed standard in the data nomenclature to use in the data entry/updating.

5.1 Component classification

Components are identified in the database according to a hierarchical taxonomy. They are categorised in “family name”, “type” and, four different “subclasses”. The last ones, to take into account four different levels of technical characteristics, such as, to better specify different components, where it needs.

A specific Table has been devoted to record the component breakdown. The related data list is available as an assistance tool in data entry, data retrieval and query of component failure data documents.

Documents on component failure data can be recorded only if a component class is assigned.

Users that recognise the need of new classes have to require the data list updating to the database administrator.

In Fig. 12 a sample of the related view.

5.2 Fusion component breakdown

A specific breakdown of components used in fusion facilities has been theorised on the base of the present knowledge in the fusion facility processes. This because, the main sets of data, which are collected in the database, come from different operating experiences than fusion, at least for the moment. Consequently, the indication about possible extrapolations on the use of data in fusion could be useful information for the database Users.

By the “fusion component breakdown” it is possible to correlate the information on generic components to systems/sub-systems/components of fusion facilities in order to give safety analysts and designers of fusion facilities indication about the specific utilisation in fusion field of the recorded data. Precisely, the systems/sub-systems/components of fusion facilities for which the collected data could be taken as reference in performing safety/reliability analyses.

Normally, in each document related to component failure data more than one “fusion class” could be indicated. This because, the generic component data collected could be taken as reference performing safety/reliability analyses of many different systems of fusion facilities.

So that, data related to a generic component is generally put in relation with all those systems/sub-systems/components by the list of fusion specific component classes.

Six hierarchical levels are foreseen to classify the components in detail: “fusion plant system”, “fusion plant sub-system”, and four different “subclasses”.

A specific Table has been devoted to record the component breakdown. The related data list is available as an assistance tool in data entry, data retrieval and query of component failure data documents.

Users that recognise the need of breakdown updating have to require it to the database administrator.

In Fig. 13 a sample of the related view.

5.3 Failure mode list

A Table, named "Failure Mode", is dedicated to record information about the failure mode of the generic component for which the data on failures have been evaluated. A "Failure Mode" data list has been prepared to assist the user in the data entry, data retrieval and query of component failure data documents.

Few samples of failure modes are:

- fail to close,
- fail to open,
- fail to reach design specification,
- fail to run,
- fail to start,
- fail to stop,
- founded during maintenance,
- internal leak,
- leakage/external leak,
- not defined failure,
- plug,
- rupture,
- short circuit,
- short to ground,
- spurious function.

5.4 Reference list

A data list named "References" is dedicated to record information about the data sources. Name of data bank or operating experience collection is reported for each document of component failure data. A "References" Table has been prepared to assist the user in the data entry, data retrieval and query of component failure data documents.

Three fields (columns) form the table:

- Reference code, for a short identification of the data sources. This code is the information recorded in the document related to component failure data.
- Description, for a detailed description of the data sources.
- Note, for comments on the data sources.

5.5 Operation mode list

In the document related to component failure data a field, named "Operation Modes", is dedicated to record information about the operating mode of the generic component for which the data on failures have been evaluated. An "Operation Modes" Table has been prepared to assist the user in the data entry, data retrieval and query of component failure data documents.

Few samples of operating modes are:

- Stand-by,
- Intermittent,
- Cyclical,
- Batch Operation,
- Continuous

5.6 Units list

Numeric component failure data need to be indicated by a unit measure, e.g.: 1/h, 1/y, 1/d (1/demand), h, etc.

A "Units list" Table has been prepared to assist the users in the data entry and data retrieval of component failure data documents.

5.7 Uncertainty distribution list

In the document related to component failure data, fields related to values where uncertainty is counted, information on uncertainty distribution type and related parameters are recorded. This is applied typically for failure rates, failure probability on demands, repair rates.

An "Uncertainty distribution list" Table has been prepared to assist the users in the data entry and data retrieval of component failure data documents.

Eight fields are foreseen in the Table: Mean value, Uncertainty distribution type, and a maximum of three parameter values, giving a quantification of the uncertainty, with related parameter descriptions. The number and kind of parameter data reported in each row of the Table depends on the uncertainty distribution type. So that in the Table there are the following fields:

- Uncertainty Distribution name,
- First Parameter Description to identify the first parameter taken into account, evaluating the uncertainty and, its related numeric format to be used showing data,
- Second Parameter Description to identify the second parameter taken into account, evaluating the uncertainty and, its related numeric format to be used showing data,
- Third Parameter Description to identify the third parameter taken into account, evaluating the uncertainty and, its related numeric format to be used showing data.

Few samples of Uncertainty Distributions are:

Uncertainty distribution	Parameters		
	First	Second	Third
Beta	scale factor	shape factor	
Discrete	5th percentiles	50th percentiles	95th percentiles
Gamma	scale factor	shape factor	
Gamma	5th percentiles	95th percentiles	
Lognormal	median value	upper bound	lower bound
Lognormal	median value	error factor	
Normal	standard deviation		
Uniform			

The format of first, second and third parameter values can be selected by the following options:

- #
- 0.0
- 0.0#
- 0.0##
- 0.0E+00
- 0.0#E+00
- 0.0##E+00

In Fig. 14 the screen map to entry/update the Uncertainty distribution.

5.8 All documents

The Table “All documents” lets to list the overall data recorded in the whole database. This is a routine available only in Lotus Notes.

This tool could be useful to see recorded data sorted by date or to realise the total quantity of data recorded.

6. Export data

A lot of information can be extracted and exported from the database to Microsoft Excel files. The Users have to select the documents they want to extract from the chosen list of data and press the dedicated button to Export data to an Excel file.

This routine is available only in the Lotus Notes frame. Users, who have available only the Internet frame, can require export of data to the Administrator, who will export the data sets required and will provide the Excel files in the Download section (see § 4). In Fig. 15 a sample of the Export view.

6.1 Fusion component breakdown

The whole Fusion component breakdown is listed by this voice of the menu. The complete list or selected records can be exported in an Excel file by pressing the dedicating button.

6.2 Component classification

The whole Component classification data are listed by this voice of the menu. The complete list, or selected records, can be exported in an Excel file by pressing the dedicating button.

6.3 Common data

The “Common data” presented in § 2 can be listed in four different ways, each one ordering the documents according to different fields and, browsing lists of different information:

- Failure data (listing fields related to information on failures);
- Fusion specific breakdown (listing fields related to the fusion class assigned to documents);
- Validation info (listing fields related to the type of validation, i.e.: effective validation process, IEA consensus);
- All fields of common data recorded in the database.

The complete list, or selected records, can be exported in an Excel file by pressing the dedicating button.

6.4 Users data

The “Users data” presented in § 3 can be listed by this voice of the menu. The complete list, or selected records, can be exported in an Excel file by pressing the dedicating button.

7. Help on line

The Help on line is available by means of dedicated routines. A sample of the help menu is reported in Fig. 16. The help documents are accessible by selecting the dedicated voice in the menu.

8. Document on components data

The data related to component failures are recorded in documents. They can be achieved from the Common Data list and the "Users Data" list. From the lists the single documents can be open by a double "click" of the mouse.

A sample of the related view is reported in Fig. 17.

The list of data is listed below.

Creation date

Date automatically entered performing the first data entry.

Created by

Name of Operator, who performs the first data entry (it is automatically entered).

Short description

Short description of the component.

Component classification

Six fields are foreseen for "family name", "type" and, four different "subclasses". The dedicated button can activate Windows of assistance for the data entry/updating by showing the Table "Component classification".

Reference

Code briefly indicating the source of data. The dedicated button can activate Windows of assistance for the data entry/updating by showing the field "Reference code" of the Table "Reference".

Operation Mode

Data indicating the operating mode of the component for which the data on failures are related. The dedicated button can activate Windows of assistance for the data entry/updating by the Table "Operation Mode List".

Failure Mode

Data indicating the failure mode of the component for which the data on failures are related. The dedicated button can activate Windows of assistance for the data entry/updating by the Table "Failure Mode List".

Component Boundaries

Free text to indicate "Boundaries" of *main component*: which parts and mechanisms are included in the *main component* itself.

Design characteristics

Free text related to "Design characteristic" description to indicate design related technical feature of the *main component.* As samples of this kind of data could be considered:

- function/application (e.g., about valves: bypass, control/regulation, isolation/stop, pressure reducing, relief/safety, vent, etc.),
- capacity performance (e.g., about valves: size, design pressure, design temperature; about electric motors: nominal power, rotational speed, nominal voltage),
- construction features (e.g., about valves: body construction type, body, seat and disc materials, kind of sealing for valves; i.e. about electric motors: cooling type, cooling medium, bearing type, lubrication type, body type, orientation),
- safety class standards.

Application characteristics

Free text related to Application characteristic description to indicate use/application related technical feature of the *main component.* As samples of this kind of data could be considered

- process related data (e.g., about valves: pressure, temperature, medium handled),
- environment related data (e.g.: type of industry, vibrations, environmental temperature, radiation, type of installation, position relative to sea-level, climate, humidity, environmental pressure),
- power factor (useful for instance in case of electric motor and diesel generators components),
- maintenance system (e.g.: inspection, breakdown, scheduled, condition monitoring).

Note

Free text field available to add information not foreseen in the other fields.

Mean Failure Rate

Data indicating the mean failure rate of the component. The unit for the value can be changed (1/h is the default value), a dedicated button can activate Windows of assistance for the data entry/updating by the Table "Units List".

Failure Rate U. Distribution

Data indicating the uncertainty on component failure rate value. The dedicated button can activate Windows of assistance for the data entry/updating of the distribution type by the Table "Uncertainty distributions List". Once entered the type of distribution, the related parameters have to be entered too.

Mean Repair Time

Data indicating the mean time to repair the component. The unit for the value can be changed (h is the default value), a dedicated button can activate Windows of assistance for the data entry/updating by the Table "Units List".

Mean Repair Rate

Data indicating the mean repair rate of the component. The unit for the value can be changed (1/h is the default value), a dedicated button can activate Windows of assistance for the data entry/updating by the Table "Units List".

Repair Rate U. Distribution

Data indicating the uncertainty on component repair rate value. The dedicated button can activate Windows of assistance for the data entry/updating of the distribution type by the Table "Uncertainty distributions List". Once entered the type of distribution, the related parameters have to be entered too.

Fusion component breakdown

Indications about possible use of the data in fusion could be recorded in the dedicated fields. A list of fusion systems/subsystems/component can be recorded in each document by the way of the Fusion component breakdown. Four buttons are foreseen to manage such data inside the document during the data entry/updating.

"Add entry" lets the user select a "fusion component class" to be added in the list.

"*Remove entry*" lets the user remove a "fusion component class" from the list.

"*Copy entry list*" lets the user to copy in a buffer memory the list of "fusion component classes".

"Paste entry list" lets the user to paste the list of "fusion component classes" from the buffer memory.

Failure Data

This is a set of data used to perform statistically evaluation on operating experience. Where available, they could give a great contribution on knowledge of component performance.

- Number of failures
- Number of components
- Number of damaged components
- Mean number of failures for single component
- Mean working time for single component (h)
- Global working time (h)
- Global number of demands
- Real global time of Component Unavailability (h)
- Real mean time of Component Unavailability (h)
- Real mean time of System Unavailability (h)
- Test interval (h)
- First date of failures
- Last date of failures

Document status

This is a set of data indicating the status of the document.

- Document: “accepted” / ”not accepted”. Each new document from Users will be entered as ”not accepted”. They will be listed as “Users data”(see § 3). Documents identified as of public utility have to be accepted in order to let the listing/browsing in the “Common Data” set (see § 2).
- Data validation: “validated” / ”not validated”. Each new document will be entered as ”not validated”. Document validation is intended as a check performed on recorded data, as well as a qualification of the data source and/or of the methodology applied to statistically evaluate the data.
- Data consensus in IEA context: “approved” / ”not approved”. Each new document will be entered as ”not approved”. The activity on the component failure rate database is set in the International Energy Agency (IEA) agreement on the Environmental, Safety and Economic Aspects of Fusion Power (IEA ESE). Precisely, in Task 5 of the IEA ESE. Participants to the IEA Task 5 have to check data and, can certificate the data with their approval.
- First data entry: automatically entered performing the first data entry.
- Last modification date: automatically entered performing the updating of the document.

9. Data recorded at present

The following records are recorded in the database at present:

- about 250 different Component Classes,
- about 470 different voices of the Fusion component breakdown,
- about 830 documents as Common data and,
- about 330 documents as Users data.

Data have been taken from the References listed in Table 8-1.

Table 8.1 – Sources of data actually recorded in the database

Reference Code	Description	Note
AICHE	Centre for Chemical Process Safety of the American Institute of Chemical Engineers - Guidelines for Process Equipment Reliability Data	Component data are particularly referred to chemical process plants. Information obtained by twenty-five different data banks
IAEA-TECDOC-478	Component reliability data for use in probabilistic safety assessment IAEA - TECDOC - 478 (1988)	Includes data sources from: Swedish reliability data book; NUREG 2815; NUREG 2728; IREP; IEEE 500; Shoreham Nuclear Power Plant PSA; NUREG CR 4550; Sizewell B PWR Preconstruction Report; Oconee Nuclear Power Plant PRA; Old PWR Reactor; Heavy Water Reactor (HWR) Assessment; Zion Nuclear Power Plant PSS; NUREG documents with LER rates; IPRD for Nuclear Plant components; EPRI NP - 2433; The German Risk Study (phase A)
INEEL-EGG-FSP-7922	L.C. Cadwallader, S.J. Piet; 1988 Failure Rate Screening Data for Fusion Reliability and Risk Analysis	Data evaluated by Idaho National Engineering Laboratory for application to fusion components. This document contains failure rate screening data for application to fusion components. The screening values are generally fission or aerospace industry failure rate estimates that can be extrapolated for use by fusion system designers, reliability engineers and risk analysts. Failure rate estimates for tritium-bearing systems, liquid metal-cooled systems, gas-cooled systems, water-cooled systems and containment systems are given. Preliminary system availability estimates and selected initiating event frequency estimates are presented. This first edition document is valuable to design and safety analysis for the Compact Ignition Tokamak and the International Thermonuclear Experimental Reactor.
INEEL/CON-2000-00347	Comparisons of Facility-specific and Generic Component Failure Rates for Tritium-bearing Components Used in Fusion Research	This paper compares component failure rates for continuous operation and function-on-demand components that confine tritium, and provides recommendations on values to use for fusion applications. Since a tritium release to the environment can create a significant public hazard, the safety and reliability of tritium systems is a very important for fusion research experiments and future power plants. Probabilistic safety assessment techniques are used to evaluate the safety of tritium handling. A foundation for meaningful probabilistic safety assessment is the application of accurate component failure rate data. The component failure rate values discussed here have been calculated and analysed from fusion research facilities, the US Tritium Systems Test Assembly and Japan's Tritium Processing Laboratory. The generic failure rate data compared in this paper were taken from published sources in the US and Canada.

Table 8.1 (cntd) – Sources of data actually recorded in the database

Reference Code	Description	Note
INEEL/EXT-98-00892	Selected Component Failure Rate Values from Fusion Safety Assessment Tasks, September 1998	This report is a compilation of component failure rate and repair rate values that can be used in magnetic fusion safety assessment tasks. Several safety systems are examined, such as gas cleanup systems and plasma shutdown systems. Vacuum system component reliability values, including large vacuum chambers, have been reviewed. Values for water-cooling system components have also been reported here. The report concludes with the examination of some equipment important to personnel safety, primarily sensors to detect hazardous conditions such as oxygen deficiency, toxic gas atmospheres, combustible gases, and airborne releases of radioactivity. These data should be useful to system designers to calculate scoping values for the availability and repair intervals for their systems, and for probabilistic safety or risk analysts to assess fusion systems for safety of the public and the workers.
INEL-EGG-FSP-10928	T.D. Marshall, L.C. Cadwallader; In-Vessel ITER Tubing Failure Rates for selected materials and coolants; March 1994	Data elaborated by Idaho National Engineering Laboratory to identify the best performer from an operational safety and availability perspective.
IREP NUREG 2728	Interim Reliability Evaluation Program Procedures Guide from NUREG/CR 2728, 1983	This data bank collects information about many American nuclear Light Water Reactors (LWRs)
OREDA	Offshore Reliability Data (1984)	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
RAC	Reliability Analysis Center: Non electronic Parts Reliability Data	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
RAGUSA	Introduzione all'analisi del rischio nell'industria	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
T-BOOK	Reliability Data of Components in Nordic Nuclear Power Plants (1992)	Data collected on report ENEA FUS TECN S&E 6/96, A. Mosso, A. Ponta, and T. Pinna, Screening of Failure Data for component typically used in Fusion facilities, March 1996
WASH 1400	Reactor Safety Study (1975)	

FIGURES LIST

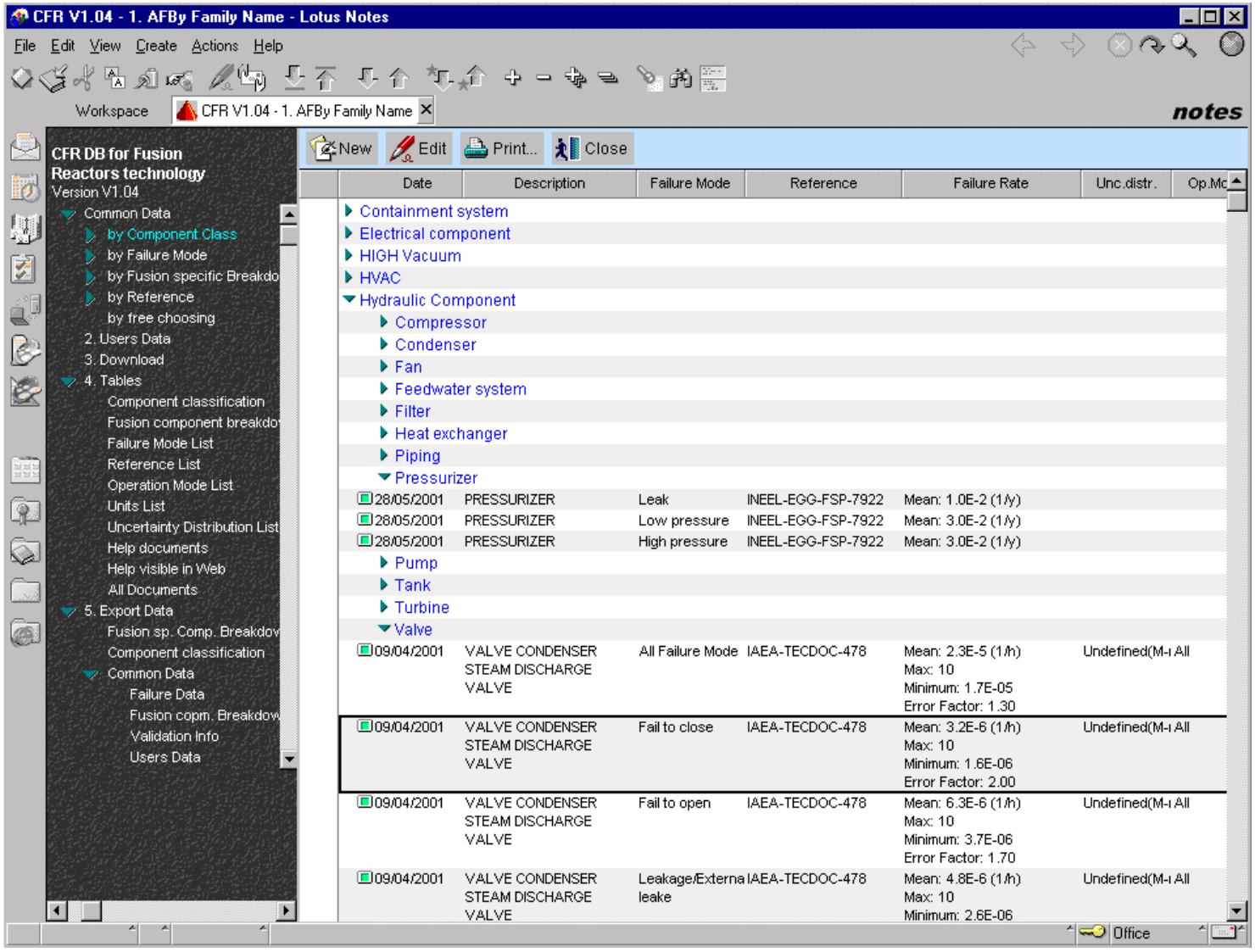

Fig. 1 Lotus Notes frame

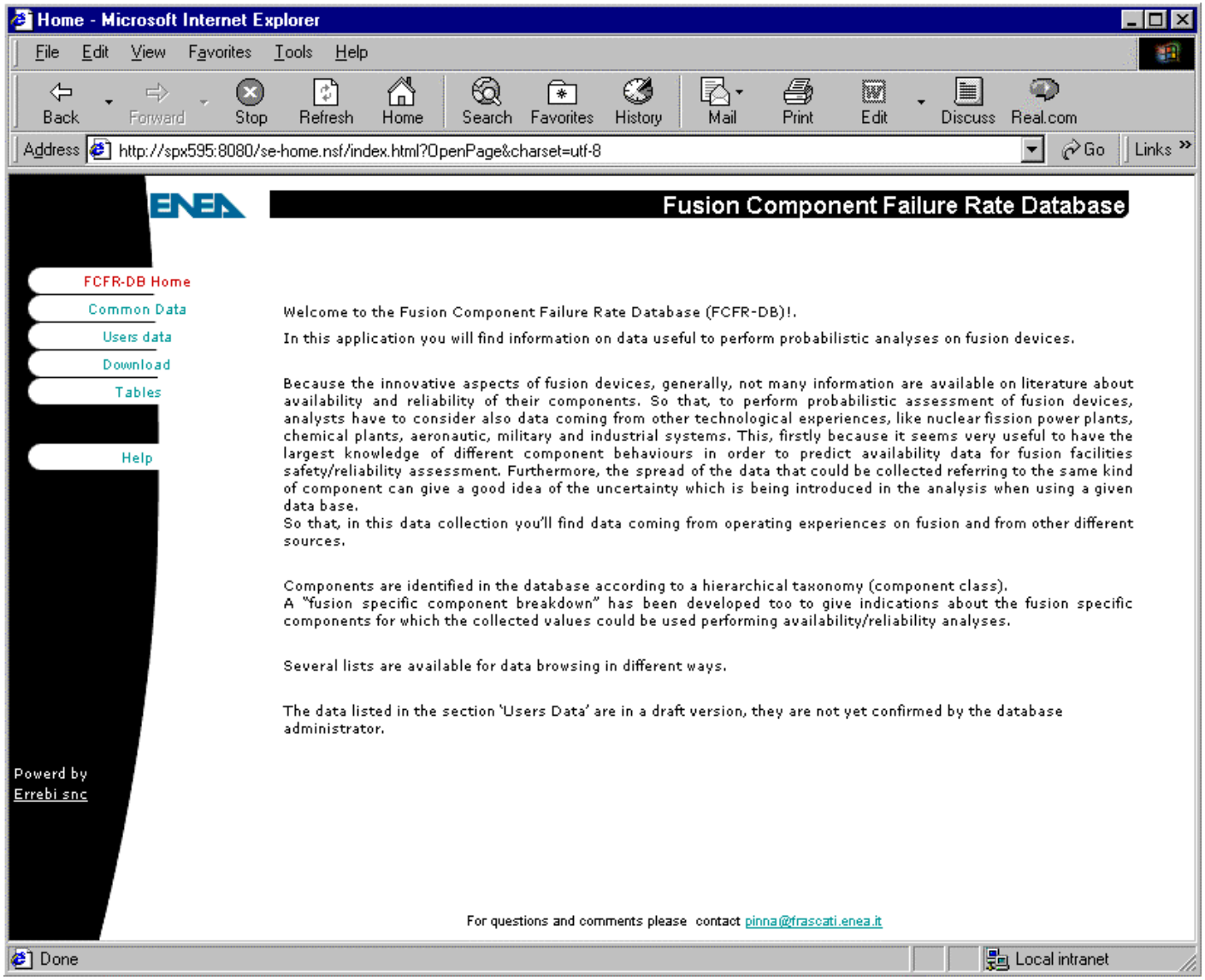

Fig. 2 Internet browser frame

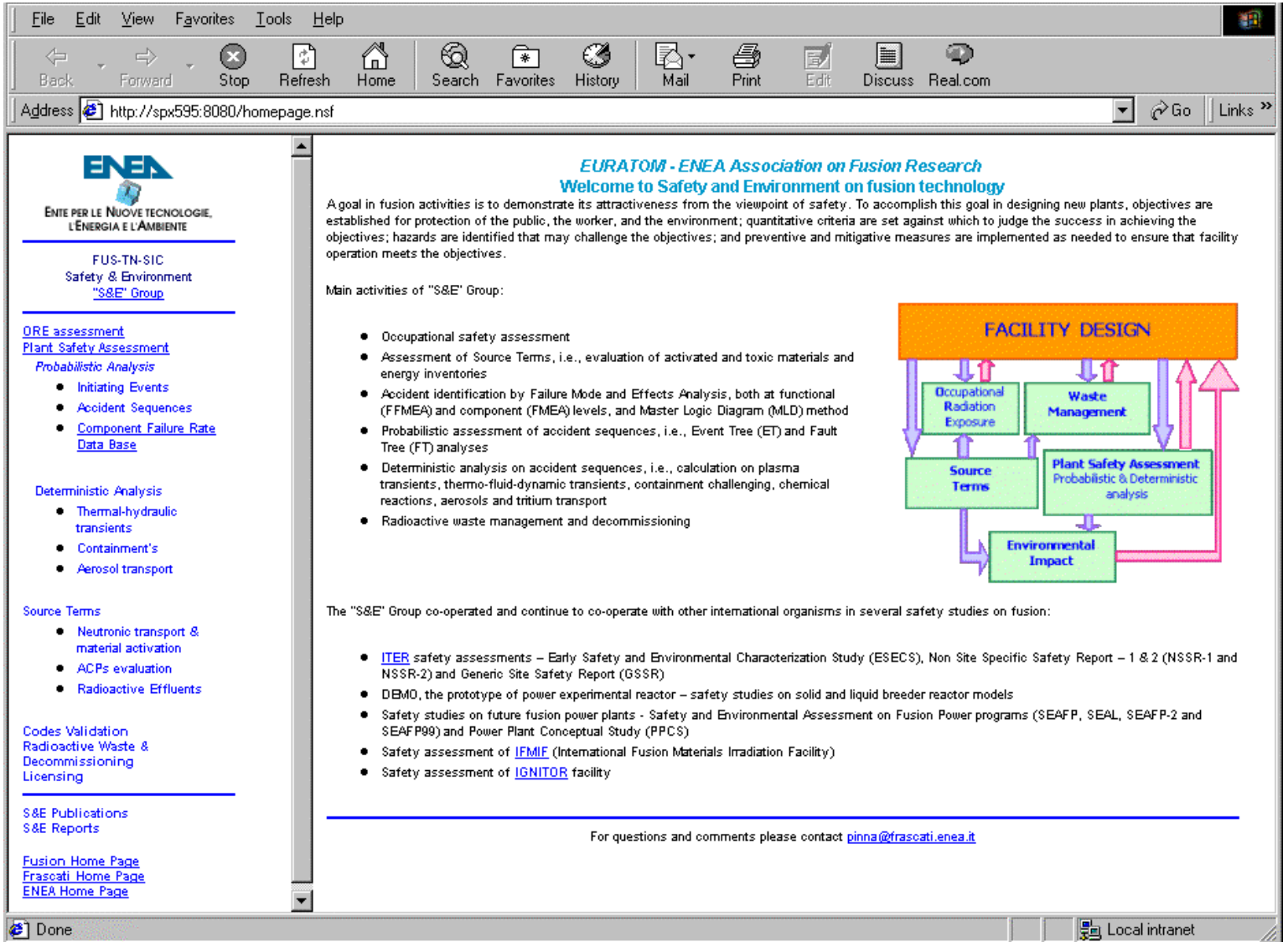

Fig. 3 view of web – site http://spx595:8080/homepage.nsf

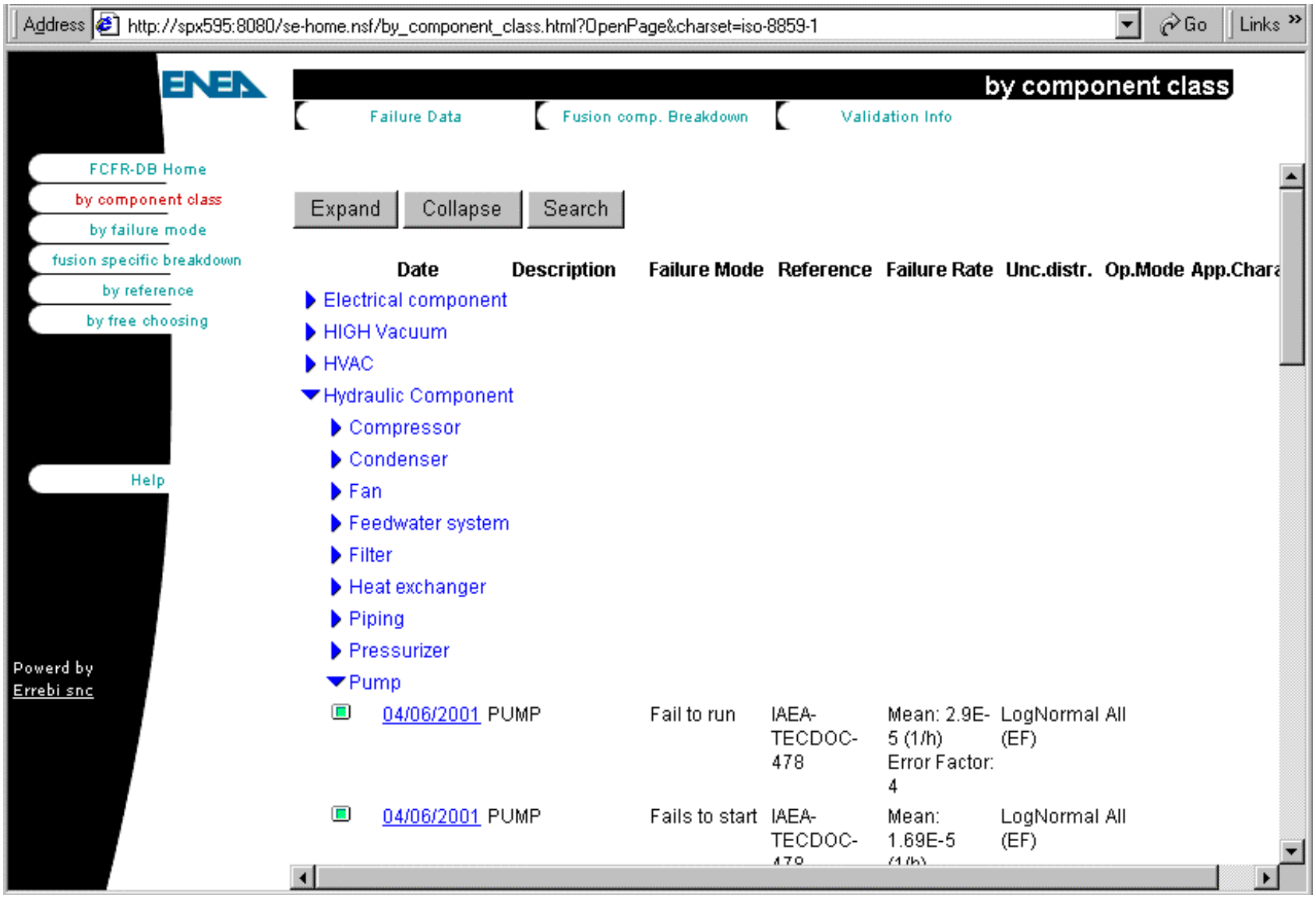

Fig. 4 Sample of Common Data list view in the Internet frame

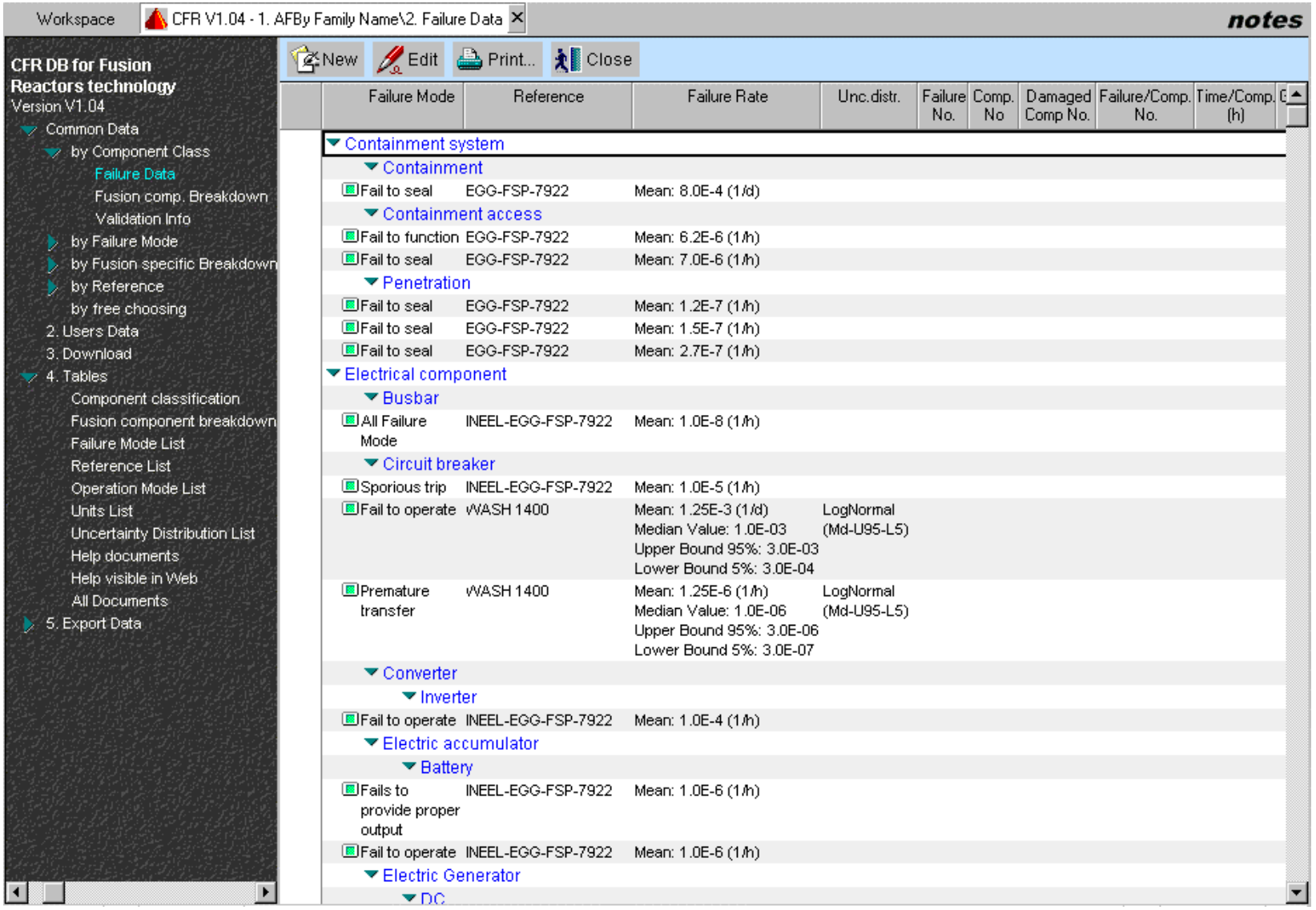

Fig. 5 Sample of Common Data list view in the Lotus Notes frame

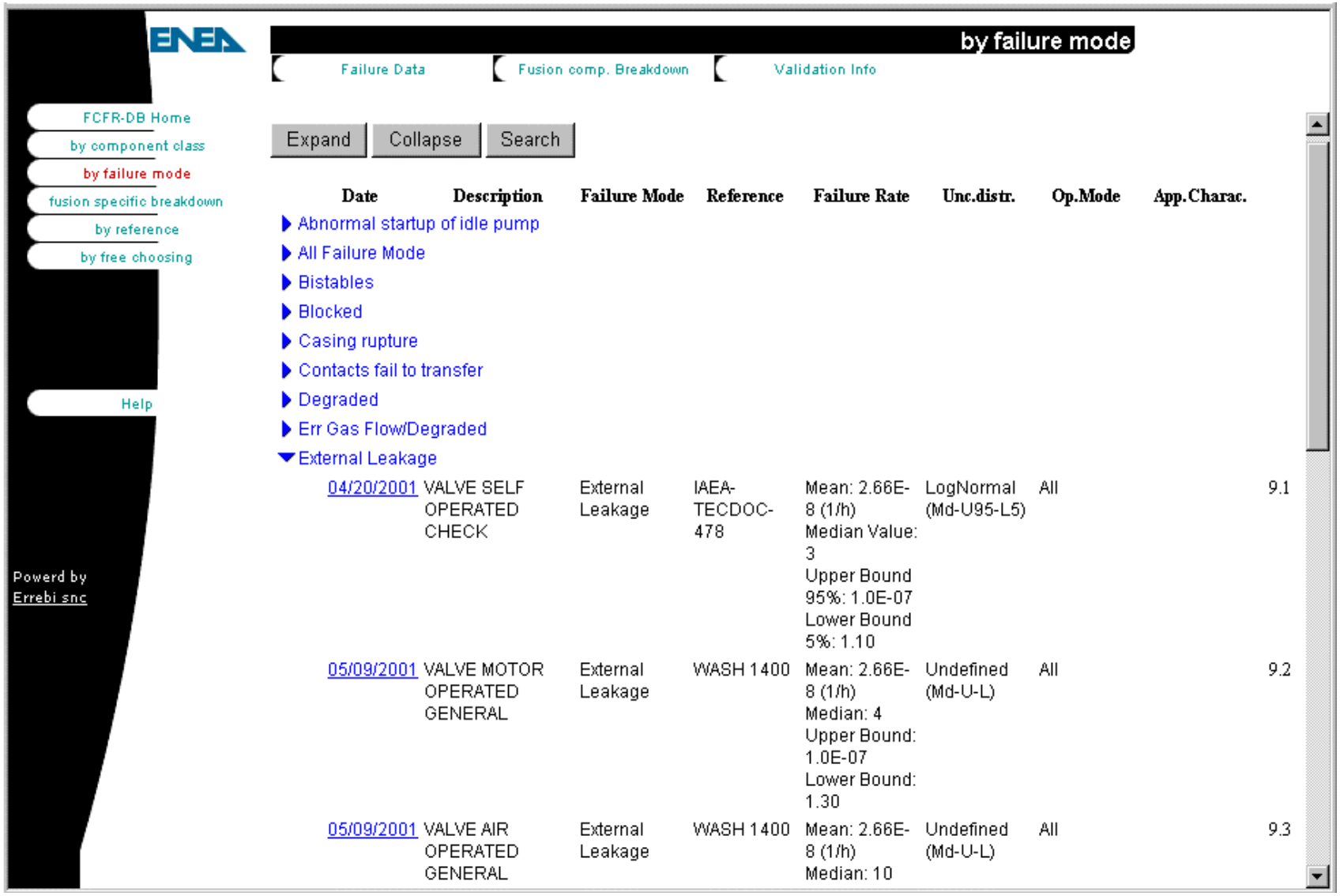

Fig. 6 Sample of Common Data list sorted by "failure mode"

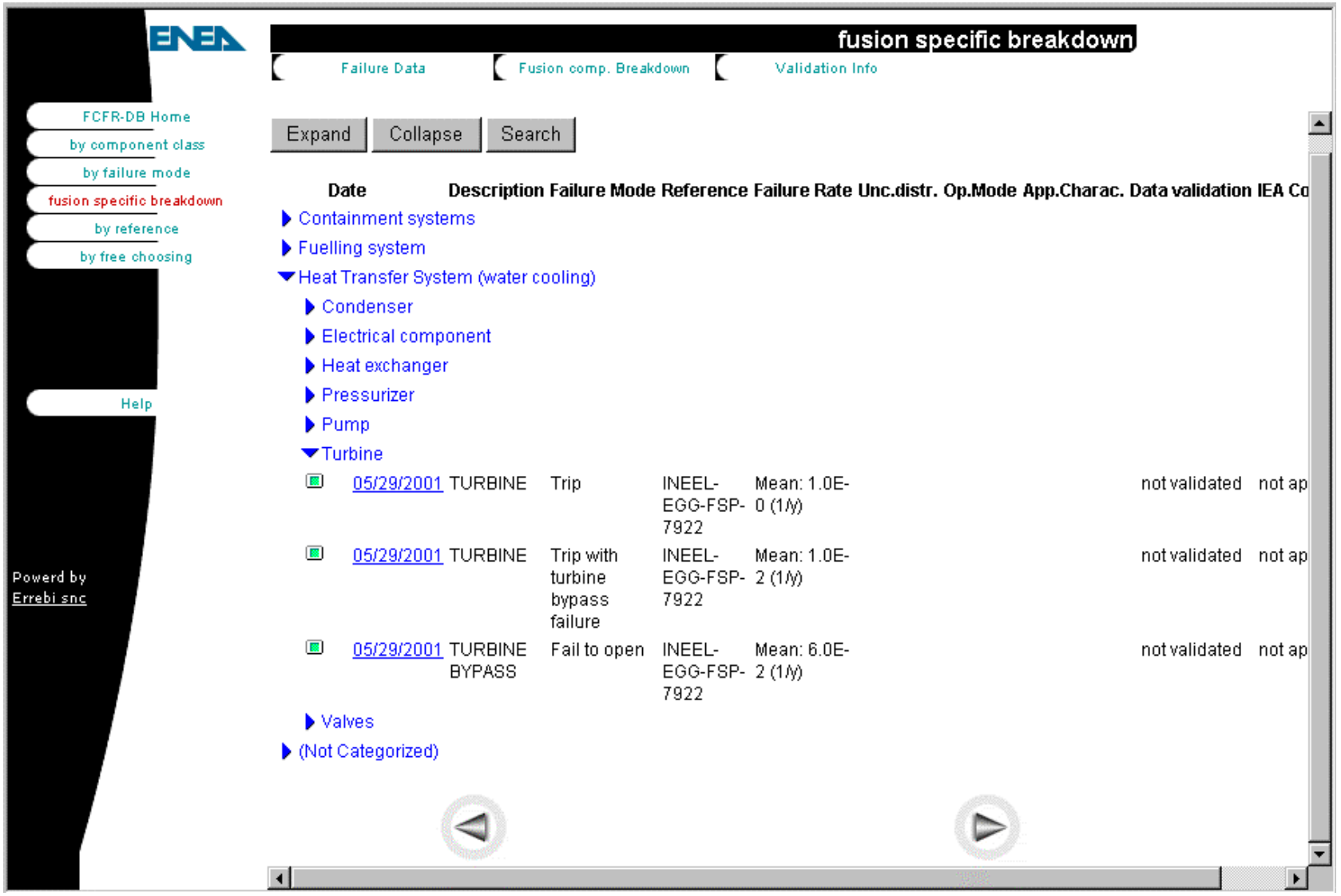

Fig. 7 Sample of Common Data list sorted by "Fusion specific breakdown"

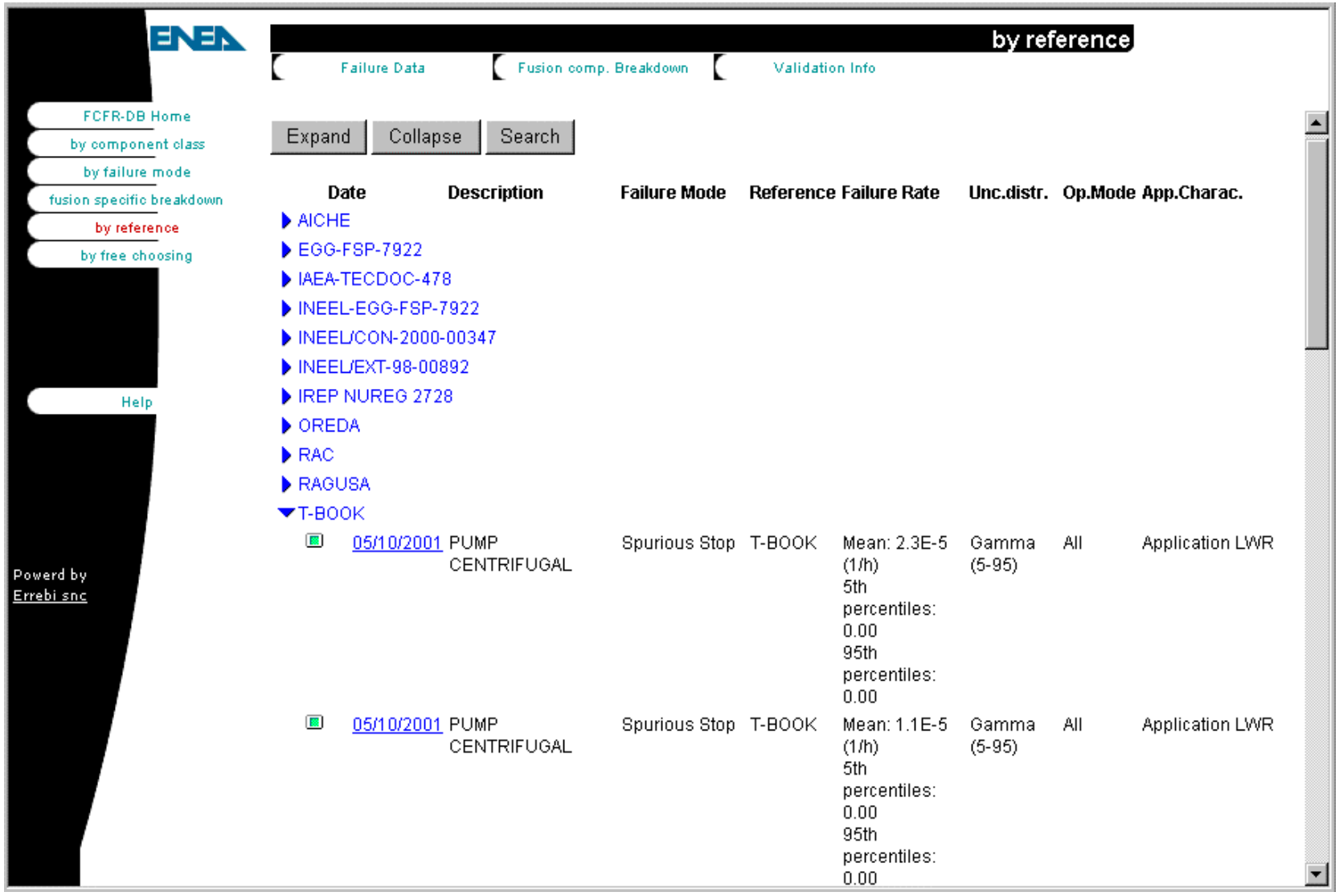

Fig. 8 Sample of Common Data list sorted by “References”

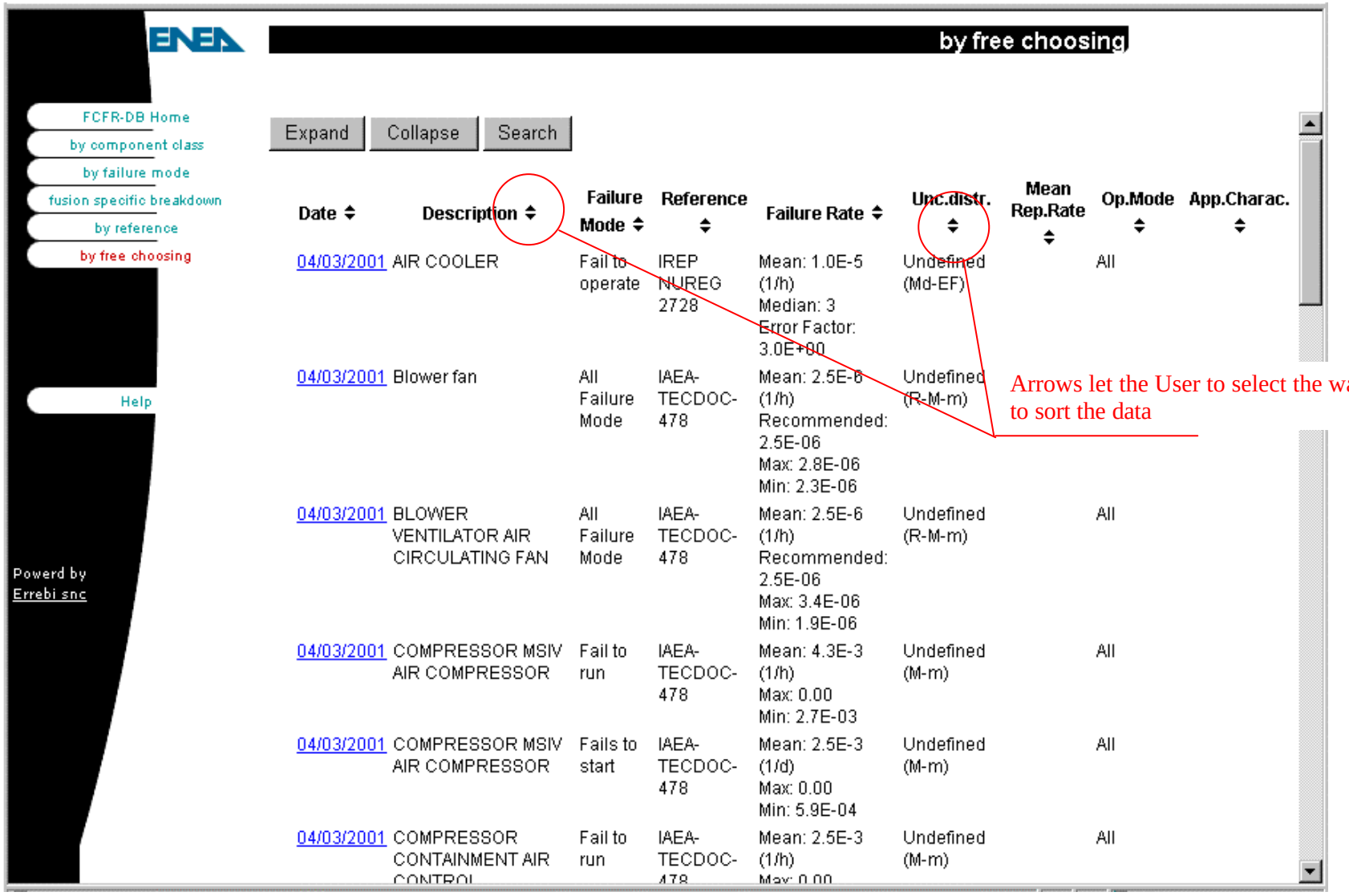

Fig. 9 Sample of Common Data list sorted by "by free choosing"

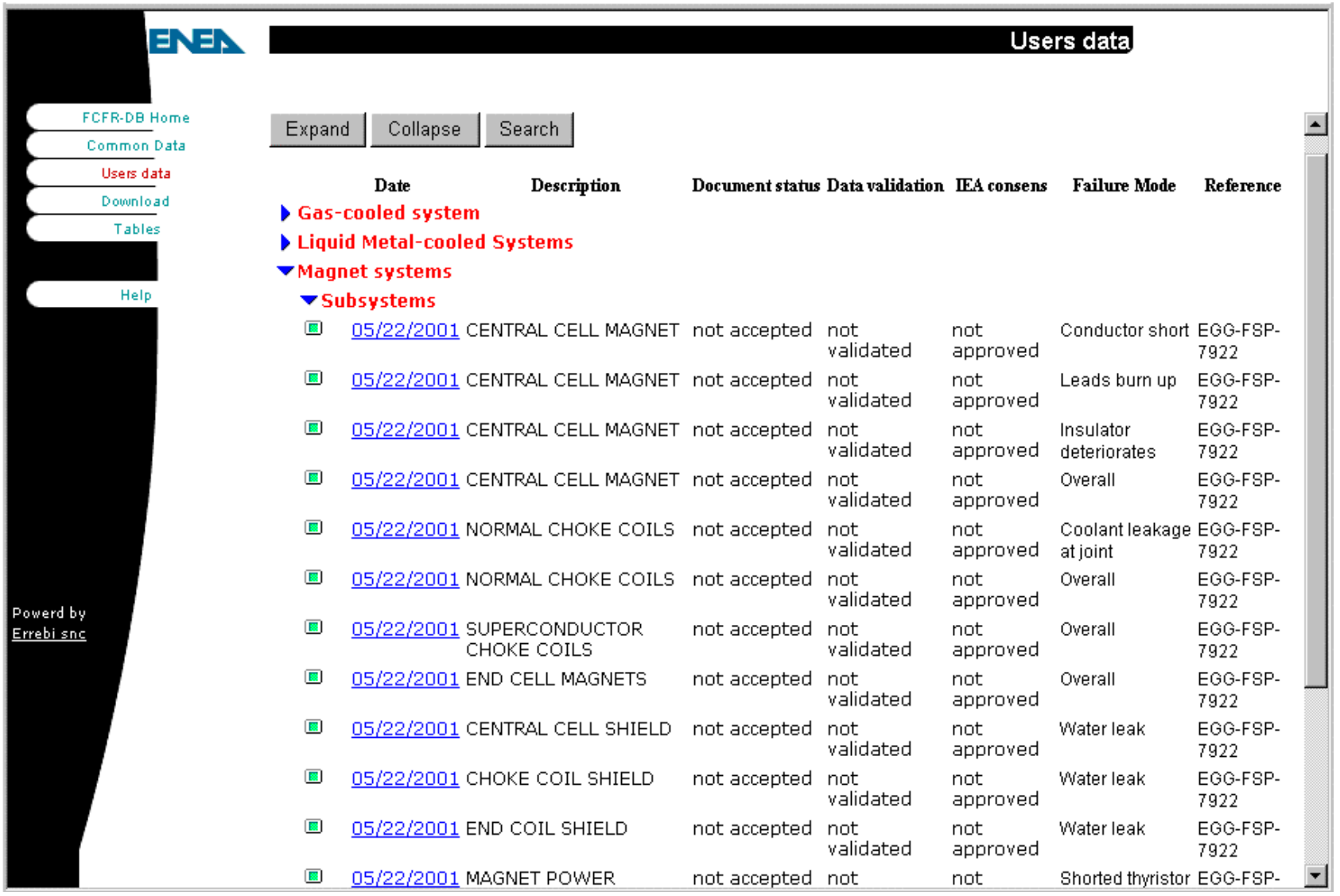

Fig. 10 Sample of Users Data

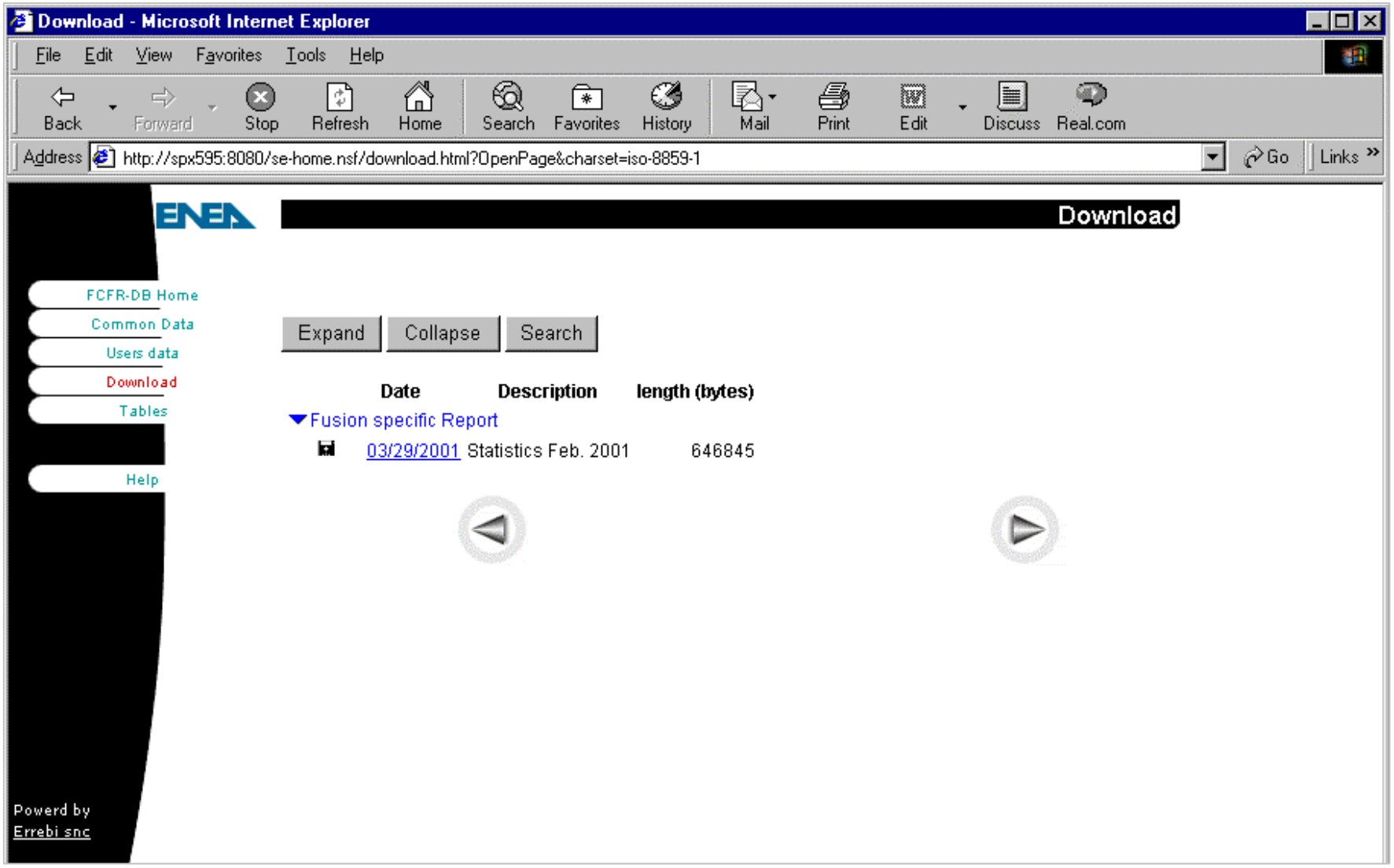

Fig. 11 Sample of "Download" view

Fig. 12 Sample of Component classes list

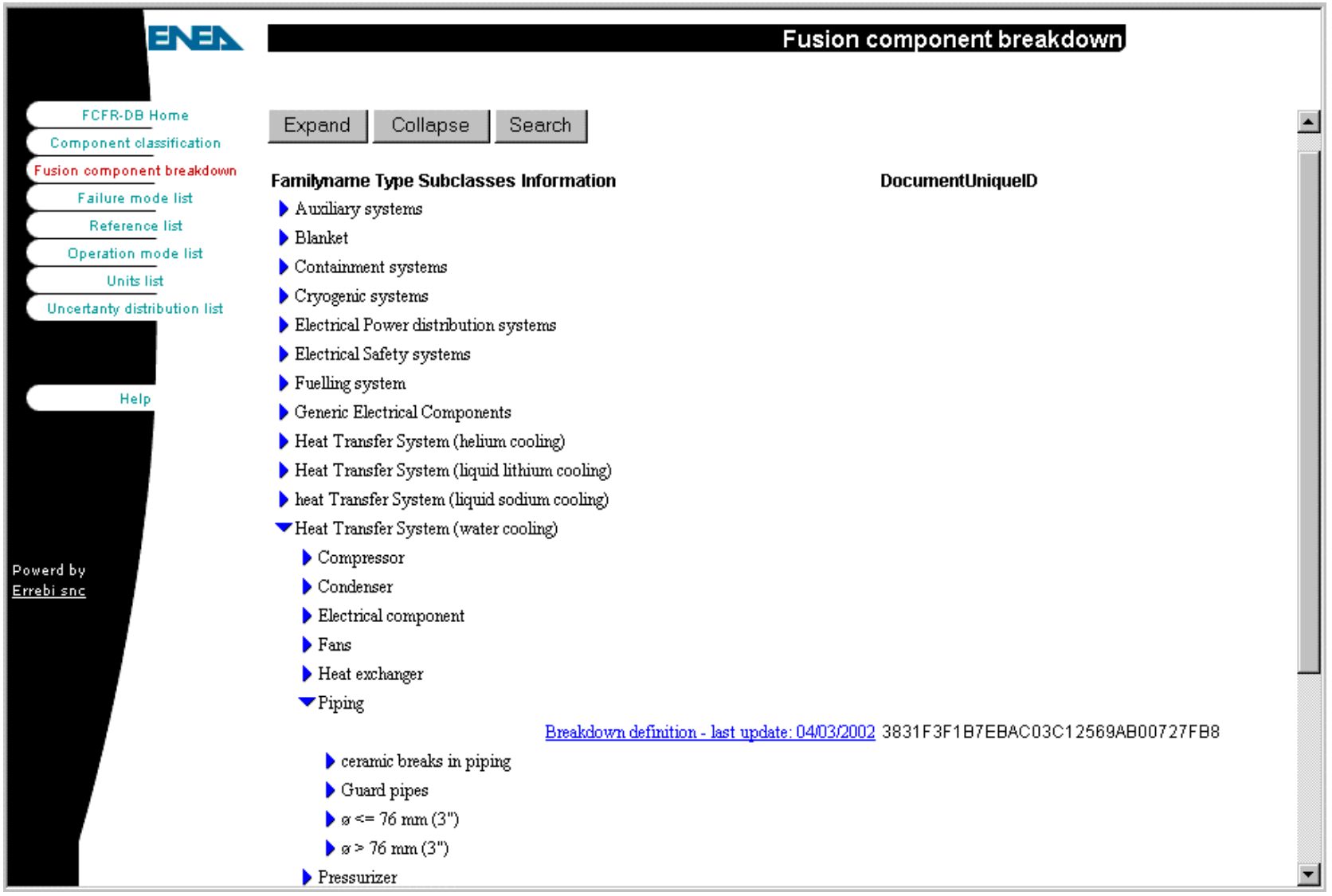

Fig. 13 Sample of Fusion component breakdown

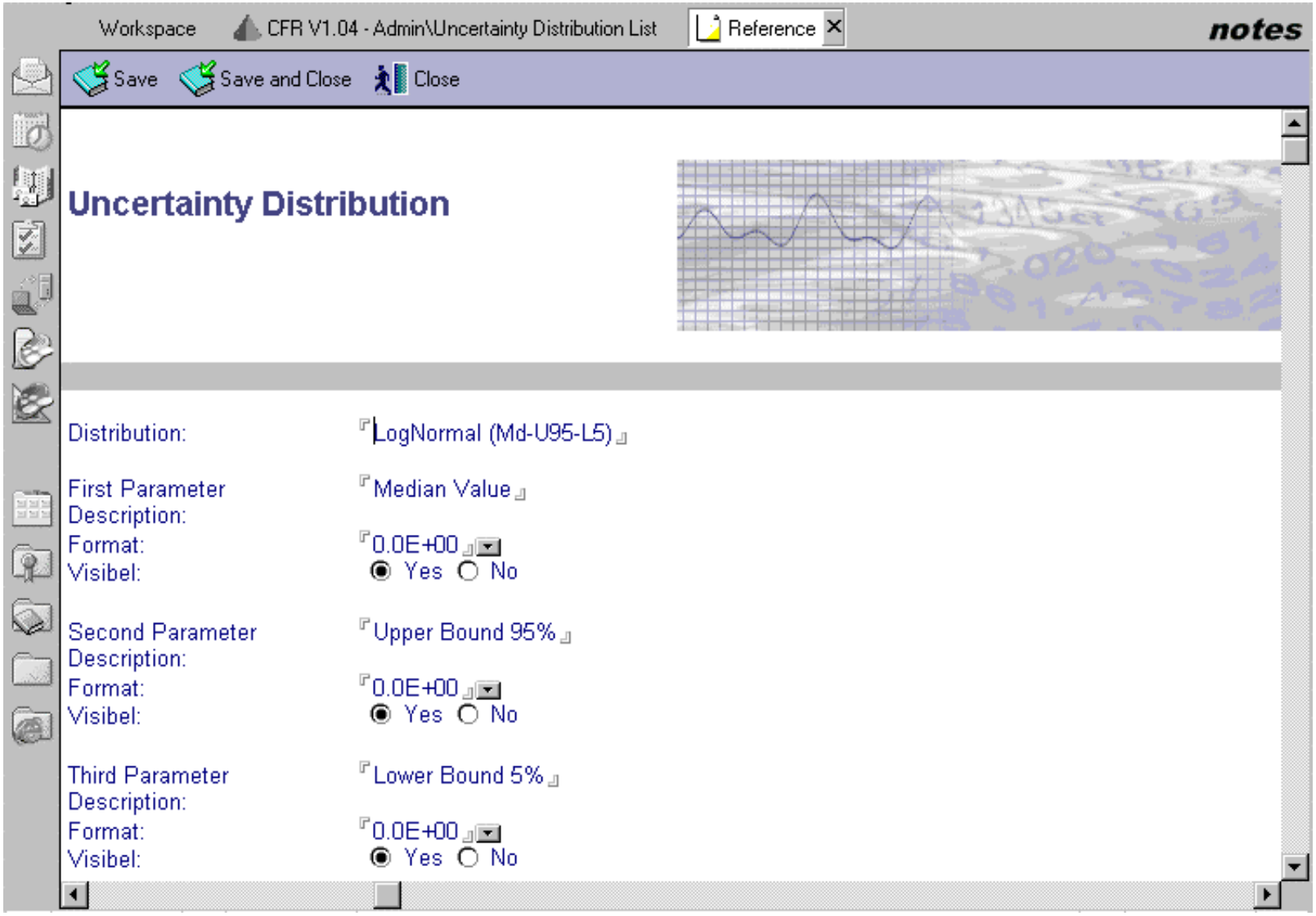

Fig. 14 Screen map to entry/update Uncertainty distribution

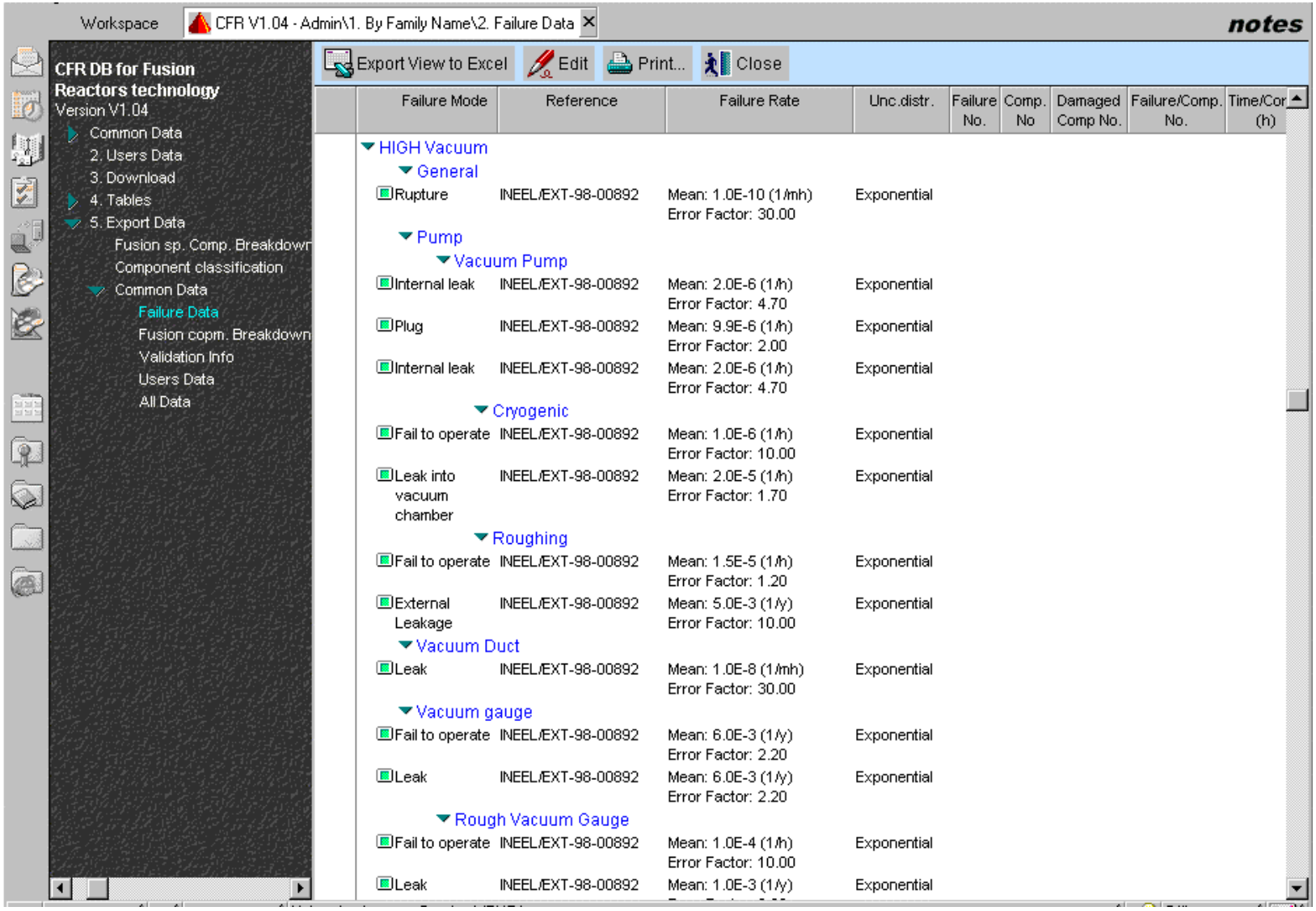

Fig. 15 Sample of Export view in Lotus Notes frame

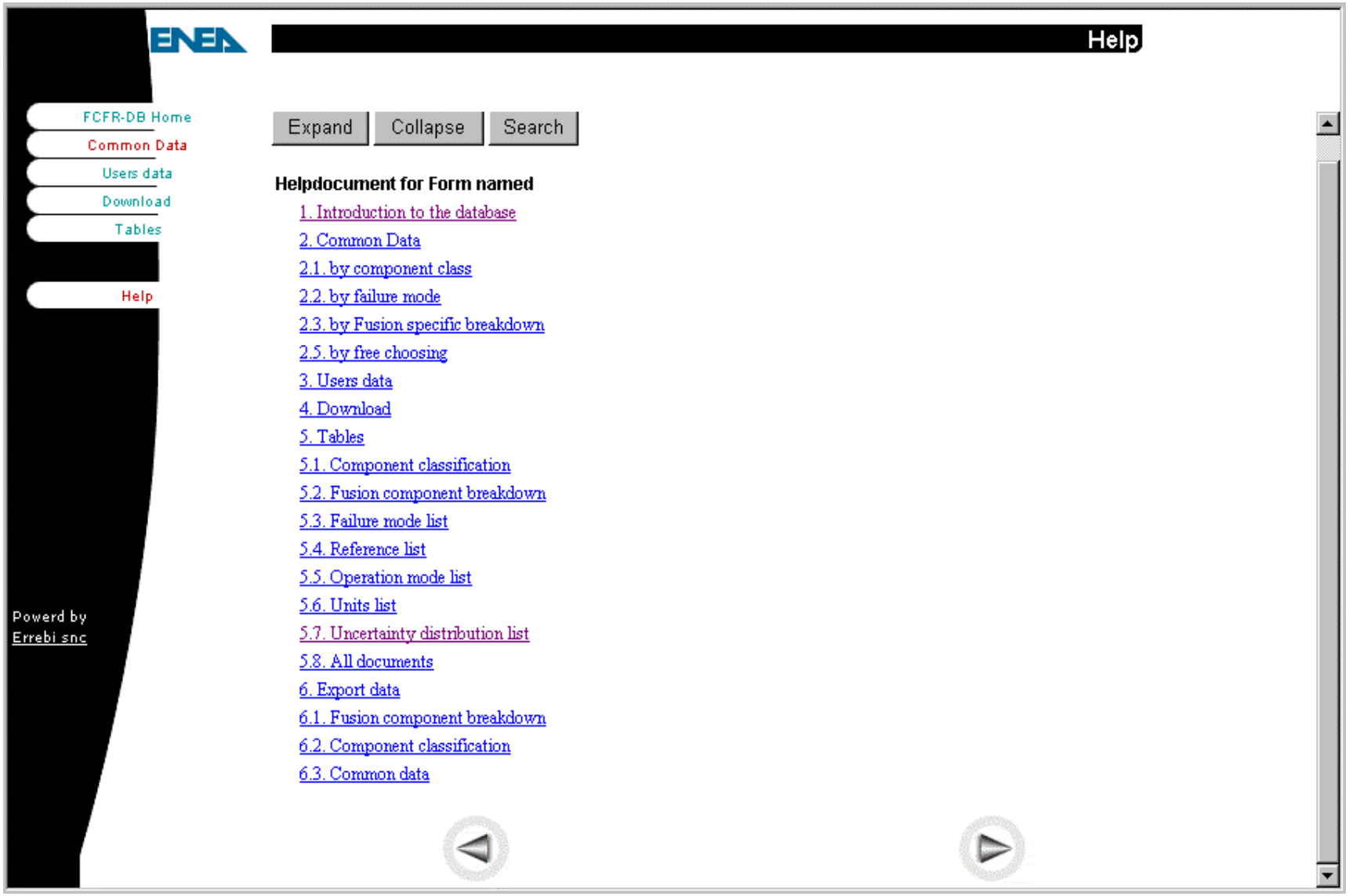

Fig. 16 Sample of Help menu

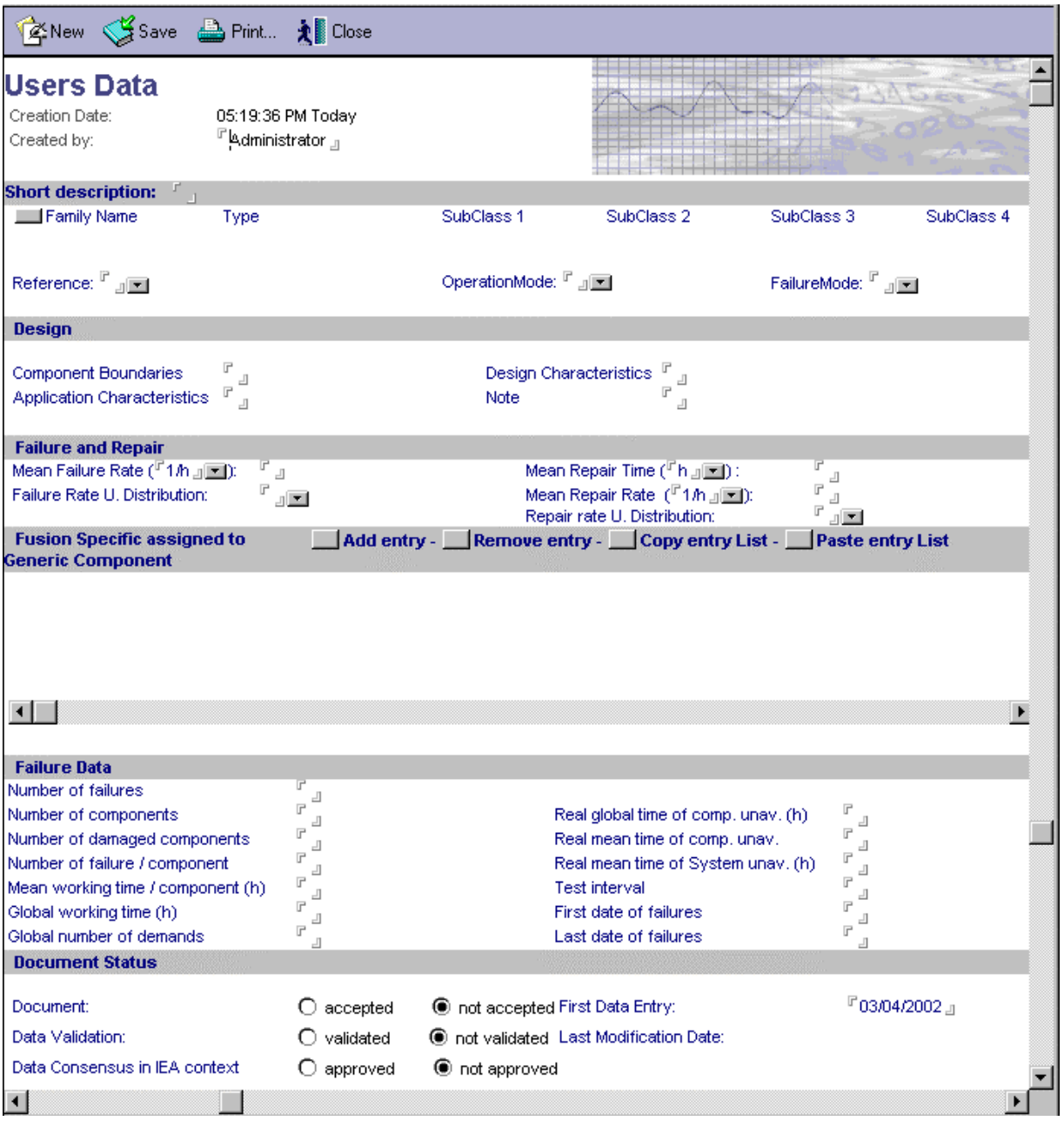

Fig. 17 Screen map of a document with components data